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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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OFFICIAL ORGAN OF THE
Illuminating Engineering Society.
(Founded in London 1909.)

This number contains the complete account of the *Discussion* on ***Recent Developments in Electric Incandescent Lamps,*** opened by Professor J. T. MORRIS at the last meeting of The Illuminating Engineering Society on December 10th, 1915.

Other Articles include :—

PUBLIC LIGHTING IN WAR-TIME—STANDARDIZING ELECTRIC TORCHES—AN ARTISTIC GAS-LIGHTED SHOW-WINDOW, &c.

ILLUMINATING ENGINEERING PUBLISHING COMPANY, LTD.
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EDITORIAL.

In accordance with our usual custom, we take this opportunity to review progress in illuminating engineering during the past year. It need scarcely be said that the war, which is imposing such sacrifices on all sections of the community, has inevitably restricted the efforts of scientific workers in many directions. This time last year, when we reviewed progress in 1914, the country had only experienced a few months of war ; now, a year later, we survey a conflict which has already lasted for nearly sixteen months, and the duration of which is still uncertain.

War conditions have reacted on the lighting industry in many ways. There has of course been an unparalelled demand for certain types of lamps and appliances required for Government and military or naval work. The restrictions of public lighting have been gradually extended and made more strict during the past year, and the memory of this dark period will certainly sink deep into the public mind. In the daily press references to the results of this diminished street-lighting are of almost daily occurrence, and, as we feared from the beginning, the number of accidents, directly or indirectly

due to the darkness, must by now have reached a considerable figure. Let us hope at least that the lesson will not be overlooked after the war, that the authorities, through the exceptional experience now gained, will come to recognise the close connection between adequate illumination and public safety, and that in the future the lighting of the streets will be carried out in a more scientific manner.

An event of great importance to the lighting industry—the issue of the First Report of the Departmental (Home Office) Committee on Lighting in Factories and Workshops—has recently been fully dealt with in this journal. The appearance of the Report, which is very opportune at the present moment when the factories of the nation are all working at high pressure, should do much to bring home to manufacturers the need for good industrial lighting in the interests of safety, hygiene, and economy. In this field there is ample scope, even in war time, for the services of illuminating engineers. The three volumes issued mark a complete departure, and should be of great assistance to engineers concerned with lighting.

At the Annual Meeting of the Society last May it was pointed out that many of the subjects for discussion during 1915 were of great interest at the present moment, notably those on Searchlights, Visibility, and the Lighting of Rifle Ranges. Another subject—the Rating and Marking of Lamps—has also been receiving attention on the Continent and in the United States.

In the United States, we are glad to see, the Illuminating Engineering Society is actively continuing its work. The proceedings at the recent Annual Convention were as interesting as usual, and the "Code" on Factory Lighting, recently issued, was a useful contribution to the literature on Industrial Illumination.

It was hardly to be expected that any great inventions or discoveries in lighting appliances could be commercially exploited in war time. At the same time it will probably be found at the conclusion of the war that manufacturers have been far from idle.

In this country we have had an opportunity of realising how dependent we formerly were on the Continent for many necessary materials and appliances used in the lighting industry, and we believe that the authorities already recognise how vital to our national existence is the proper encouragement of applied science. In the present critical period, when so great a demand on our men and resources is being made by military and naval requirements, it is the clear duty of the non-combatant section of the population to keep alive the scientific spirit, and to persevere as far as possible in the conduct of scientific research. Such work, although less spectacular, is as necessary for the future welfare of the country as the efforts of those in the field of battle. The wisdom of this view has been officially recognised by the creation of a Committee of the Privy Council now engaged in preparing a scheme to establish a permanent organisation for the promotion of Industrial and Scientific Research. The Committee is aided by an Advisory Council who will advise on proposals for instituting researches, establishing research studentships, &c. We are glad to see that the scheme aims at co-operation with existing scientific and professional bodies, many of whom are now carrying out valuable work in most trying circumstances. We are also glad to note the permanent character of the organisation which, we hope, will constitute a source of encouragement to scientific enterprise and will profoundly influence our industries in time to come.

The Development of Electric Incandescent Lamps in Relation to Illuminating Engineering.

The discussion on this subject opened by Professor J. T. Morris at the last meeting of the Illuminating Engineering Society (see pp. 5—26) brought out several interesting points. Methods of lighting interiors are necessarily affected by the range of candlepower and efficiency of the lamps available, and it is not surprising to find that as a result of the introduction of more powerful and efficient incandescent lamps general over-head lighting is being exploited to a considerable extent in many cases where local lighting with low candlepower lamps would formerly have been used. The rise in intrinsic brilliancy (which according to Professor Morris reaches over 5,000 candles per square inch in the case of the "half-watt" lamp), has made proper methods of shading essential, and given some encouragement to the use of indirect and semi-indirect methods of lighting.

Simultaneously with the greater range in candlepower we find considerable variations in the shape of filament, and several speakers referred to the necessity for careful selection of the lamp to suit the reflector; in fact, lamp and globe or reflector should be regarded as one "lighting unit." Professor Morris has found that lamps of the "bunched filament" type, having a high powerful downward light component, may prove exceptionally efficient for certain purposes, since they enable a high illumination to be readily obtained on the working plane (naturally at the expense of light, which would otherwise be emitted at other angles). This point is also touched upon in a contribution to the Bulletin of the Swiss Institution of Electrical Engineers, which we reproduce on p. 29. The view is expressed that notwithstanding the apparent gain as regards distribution of light, it seems advisable to aim at producing a standard type of lamp, which can be made cheaper and more reliable, and to modify the distribution of light by using appropriate reflectors. This view would probably commend itself to most lamp-manufacturers. Again, whilst agreeing that the gas-filled or so-called "half-watt" lamps represent a distinct advance in efficiency, we hope that manufacturers will exercise restraint in the introduction of new high voltage and low candlepower units, and that they will make sure that the type is thoroughly serviceable—*i.e.*, that it has a satisfactory life and can be sold at a reasonable price—before it is given to the public. In the case of general lighting with comparatively powerful lamps this is specially important, as the failure of one lamp is not only an item of importance as regards the cost of maintenance but may lead to a section of a workroom being left in comparative darkness.

Another feature of interest at this meeting was the exhibition, by Mr. S. R. Mullard (for the first time in public), of a form of lamp using an incandescent ball of tungsten within a sealed bulb. Although in a sense an "arc" lamp, it requires no manipulation once it is started, and being a close approximation to a "point-source," may have interesting applications for projection work. It is too early as yet to predict the full applications of the lamp, but its appearance at the present moment is a testimony to the enterprise of the Ediswan Laboratories.

Supply Companies and Illuminating Engineering.

The war has imposed difficulties on many companies engaged in the supply of gas and electricity. In manufacturing districts the diminution in the private lighting demand has been, to a great extent, offset by the increased opportunities for heat, light, and power in the factories in the locality; but in other cases, such as the residential districts of London, this compensating advantage does not exist. In addition to the loss in revenue expenses have risen, and it is natural that companies should desire to increase their rates temporarily so as to make good the deficit.

Most people would be willing to agree that such a course may be natural and inevitable in the present circumstances. But from the public standpoint the exact form of the increase is a matter of some moment. In several cases which have come under our notice, we observe that electric lighting companies have not been satisfied with merely increasing their rates, but have taken advantage of the situation created by the war to terminate their old contracts and scale of charges, based on the flat rate, and to substitute other arrangements, which in some cases constitute a hardship to old consumers. Methods which might strike the company as quite reasonable in the present circumstances when applied to new consumers, may be unjust to consumers of old standing; and the welfare of the supply company is inevitably prejudiced if any large section of such consumers feel they have a grievance.

From the illuminating engineering standpoint, it is well known that the best results are obtained by allowing adequate subdivision of the lighting sources, using at each point only the candlepower needed to produce the required illumination, and that ample switching arrangements, enabling only those lamps actually required at any moment to be switched on, are essential for convenience and economy. The system of charging on the total lamps installed, irrespective of the fact that the whole of the lamps will never be in use simultaneously, penalises consumers who adopt proper methods of lighting and encourages parsimony of a very injudicious kind.

We mention this point because it illustrates the importance of supply companies, whether gas or electric, co-operating with the general public and advising them to use their light to the best advantage. Taking a far-sighted view, it is clearly to the interest of companies to do this, and as a result of the work of the Illuminating Engineering Society there are now ample opportunities for their staffs to become familiar with the requirements of good lighting. Companies should, therefore, recognise the benefit of studying these matters, so that their representatives may be in a position to induce existing consumers to exercise a wise generosity in the use of light, taking advantage of the latest developments in electric lamps, and thus raising the status of lighting to a higher level.

We strongly believe that a great deal more might be done by supply companies than at present to interest the consumer in illumination, and to lead him to appreciate that light is a real necessity and not a luxury, and that economy beyond a certain point is inefficient and unwise. At the present time, when there is a great need for discrimination in economy, supply companies have a duty in this respect, and for their own future it is incumbent on them to take much more interest in illuminating engineering than they have done hitherto.

LEON GASTER.

TRANSACTIONS

OF

The Illuminating Engineering Society.

(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

RECENT DEVELOPMENTS IN ELECTRIC INCANDESCENT LAMPS IN RELATION TO ILLUMINATING ENGINEERING.

(Discussion at a meeting of the Society held at 8 p.m. at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, on Tuesday, December 10th, 1915.

A MEETING of the Society took place at the House of the Royal Society of Arts on Tuesday, December 10th, the CHAIR being taken by Professor SILVANUS P. THOMPSON, D.Sc., F.R.S.

The minutes of the last meeting having been taken as read, the HON. SECRETARY announced the names of new members in the usual way, and the CHAIRMAN then called upon Professor J. T. MORRIS to open the discussion on "Recent Developments in Electric Incandescent Lamps in Relation to Illuminating Engineering." A discussion followed, in which Mr. S. R. MULLARD, Mr. F. W. WILLCOX, Mr. W. R. COOPER, Mr. A. CUNNINGTON, Mr. E. STROUD, and Mr. L. GASTER took part. Professor J. T. Morris intimated that he would reply to the various comments in the Journal of the Society.

The Chairman announced that the next meeting would take place on **Tuesday, January 11th,** when a discussion on **Some Problems in the Lighting of Factories and Workshops, with special reference to the Departmental Report,** would be opened by Mr. J. S. Dow.

Votes of thanks to Professor Morris for opening the discussion, and to Professor Silvanus P. Thompson for presiding, terminated the proceedings.

NEW MEMBERS.

AT the meeting of the Society on December 10th the names of applicants previously read out at the meeting on November 23rd were announced again, and these gentlemen were formally declared members of the Society.

In addition, the following new names were announced :—

Vice-Presidents :—

Sparks, C. P.	Chief Engineer of the County of London Electrical Supply Co., *President of the Institution of Electrical Engineers.*
Young, John.	Chief Engineer of the Gas Works, Hull, *President of the Institution of Gas Engineers.*

Ordinary Members :—

Pillinger, G. C.	London Manager, Messrs. R. A. Lister & Co., 47, Victoria Street, LONDON, S.W.

RECENT DEVELOPMENTS IN ELECTRIC INCANDESCENT LAMPS IN RELATION TO ILLUMINATING ENGINEERING.

By J. T. MORRIS.

(Professor of Electrical Engineering at East London College.)

(Introduction to Discussion which took place at a meeting of the Illuminating Engineering Society at the House of the Royal Society of Arts, London, at 8 p.m., on Tuesday, December 14th, 1915.)

MY intention in these introductory remarks is to make a general survey of the recent developments in incandescent lamps during the last few years, particularly as regards range of candlepower and nature of filament; to trace the influence of these developments on the design of shades and reflectors, and on general problems in illuminating engineering.

TABLE I.—SHOWING DEVELOPMENT OF ELECTRIC INCANDESCENT LAMPS.

Nature of Filament.	Date introduced.	Voltage.	C.P.	Watts/C.P.
Carbon	1880	to 100	10—50	5·0
	1889	to 200		
Nernst	1898	110	65	1·5
	1903	250	130	1·5
Osmium	1902	65	35	1·7
Tantalum	1905	to 110		1·9
Tungsten, squirted	1906	to 100	8—50	1·25
	1908	100	6—300	1·25
	1909	230	8—1000	1·25
Tungsten, drawn wire ..	1910	100—250	20—1000	1·25
"Half-Watt"	1913	50—250	750	·65
	1915	25—250	30—3000	·65
Tungsten "Arc Incandescent"	1915	50	100	0·65

Table I. serves to illustrate the gradual development which has taken place in incandescent lamps. Data as regards the range of candlepower, efficiency and date of introduction of various lamps are given from the carbon filament to the "half-watt" or gas-filled lamp, and the still more recent "tungsten arc incandescent" lamp, on which I shall have something to say shortly.

From the figures available it appears that about 75 per cent. of the present lamp output consists of metal filament lamps, and probably it is now only a question of time before the carbon filament lamp becomes practically extinct. It is interesting to observe the great advance made during the last ten years in the range of candlepower available. The introduction of metal filament lamps, giving only a few candles, led to a great development in many portable appliances, such as torches, miners' lamps, and motor-car headlights; while with gas-filled lamps as much as 3,000 candles is now concentrated in a single unit. (In the United States gas-filled lamps, giving as much as 10,000 candles, are said to have been prepared.)

It is also of interest to observe in which countries the various lamps have been developed. The carbon filament lamp was developed partly in the United States and partly in this country; the Nernst lamp in Germany; the Tantalum lamp in Germany; the tungsten lamp and the half-watt lamp partly in Germany and partly in the United States.

The very latest type of lamp on the list,

the "tungsten arc incandescent," is to be shown in public for the first time this evening, and is still in the experimental stage. This source might be more correctly described as an "incandescent ball" of tungsten. It is a most interesting novelty, and it is gratifying to observe that it has been developed entirely in the Ponders End Research Laboratory, of the Edison and Swan United Electric Light Co. It is satisfactory to find that, even in the present circumstances, Englishmen have the foresight and determination to attempt and carry to a successful conclusion a research of this kind. The lamp is really an arc in a hermetically sealed glass bulb, and thus combines in many respects the advantages of an arc and an incandescent lamp. The arc is formed between a globule of tungsten and a rod composed of special ionising materials, the globule becoming incandescent, thus forming an approximation to a "point source." From a physical standpoint the lamp behaves like an arc but, being entirely confined within the glass bulb, does not require manipulation by the operator in any way. The specific consumption is about 0.65 watts per candle, but I understand that by forcing up the current 0.32 watts per candle can be attained. The globe is filled with an inert gas such as nitrogen or argon. The tungsten globule, one-tenth of an inch in diameter, is supported on a bi-metallic strip. Immediately above this globule is a rod composed of tungsten and also containing special materials which, when heated by the passage of an electric current, ionise the space between the rod and the ball of tungsten and enable an arc to be struck and maintained. The action of the heat on the bi-metallic strip causes the ball to travel slowly across the filament below it, this movement serving as a protection to the ioniser. The arc itself gives practically no light, the candlepower of the lamp being centred in the tungsten globule. Some tests on the relation between candlepower and voltage gave interesting figures; with a carbon filament lamp 1 per cent. change in current means 5 or 6 per cent. change in candlepower; with metal filament lamps the corresponding variation is less; while with the tungsten "arc incandescent" 1 per cent. change in current causes a change of only about 2¼ per cent. in the light.

Table II. summarises some other important properties of electric lamps. It has often been remarked that each gain

TABLE II.—INTRINSIC BRILLIANCES OF ELECTRIC INCANDESCENT LAMPS.

Nature of Filament	C.P. or Watts.	Volts.	W/C.P.	Length. inches.	Diam. mils.	Cross Sectn. "sq. mils."	Proj. Area. sq. in.	Intrinsic brilliancy (c.p./sq. in.)
Carbon	50 c.p.	100	3·5	10·5	12·5	123	0·1312	381
	50 c.p.	200	4·0	13·7	8·7	59·5	0·119	420
Nernst	66 c.p.	95	1·8	0·59	52·4 tube	—	0·031	2150
Osmium	32 c.p.	55	1·9	16·0	4·	12·5	0·062	520
Tungsten	60 w.							
Drawn wire ..	54·5 c.p.	100	1·1	24	2·2	3·8	0·053	1030
	60 w.							
	52 c.p.	200	1·15	36·5	1·3	1·325	0·0475	1095
"Half-Watt" ..	360 w.	80	0·67	20	7·1	39·5	0·072	5000
	1490 w.	240	0·58	—	9	64	0·49	5250
Tungsten "Arc Incandescent" ..	100 cp.	50 (?)	0·65	globule	100	—	0·0078	12900

Tungsten (melting point) ....for comparison 46500
Crater of carbon arc ....for comparison 111000

in efficiency of modern illuminants has been accompanied by a corresponding increase in the concentration of the light so that the intrinsic brilliancy has steadily risen, reaching over 1,000 candles per square inch in the ordinary tungsten lamp. Naturally this high intrinsic brilliancy makes it necessary to shade the filaments from the eye, and has led to the development of greatly improved shades and reflectors. Somewhat variable figures have been given for the still higher intrinsic brilliancy of the "half-watt" lamp, but a recent test in the laboratories of the East London College gives a value exceeding 5,000 candles per square inch, which fully bears out the necessity for proper methods of shading with lamps of this type. As regards the "tungsten arc incandescent lamp" I find the intrinsic brilliancy in this case to be much higher still, namely, 12,500, which is ten times that of the ordinary tungsten lamp. For the sake of comparison the intrinsic brilliancy of tungsten at its melting point, 46,500, and the positive crater of the arc between carbon electrodes, 111,000 candles per square inch are also included in the table.

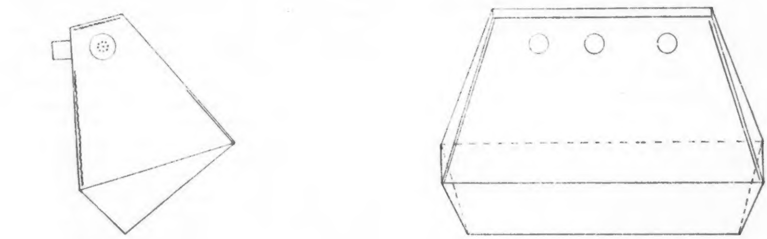
(NOTE.—Figures relating to the Osmium lamp have been added to these tables at the suggestion of the Chairman.)

In passing it is worth notice that high intrinsic brilliancy, which is inconvenient for purposes of illumination, is exactly what is needed for certain branches of optical work, *e.g.*, for cinematograph and optical projection and for searchlights. In this case we want the nearest approach to a point-source, and the "enclosing area" of the filament, besides its intrinsic brilliancy is also important. The best results are obtained from a small spot of light of intense brilliancy, and it is well recognised that the crater of the carbon arc has hitherto surpassed all other sources in this respect. By using closely packed filaments of spiralised drawn wire the desired conditions can be approached, but in these circumstances the source is not really a "point," but a complicated series of lines which reveal themselves in optical projection. The new "tungsten arc incandescent," on the other hand, consists of a continuous glowing surface, and it will be interesting to see whether this will have important applications for projection work.

(In order to illustrate the difference in the arrangement of filament in various lamps the lecturer at this stage projected on the screen the filaments of a number of actual lamps, including the new "tungsten arc incandescent" lamp.)

Apart from their special applications for projection purposes in motor-car headlights, lanterns, &c., it is of interest to inquire whether the close-packed spiralised filaments are not more advantageous, with a view to better distribution of light with modern reflectors. With the ordinary straight filament a great deal of light is emitted horizontally, and this light must be subsequently directed downwards by reflectors. But with some forms of spiralised filament lamps, the percentage of light emitted immediately below the reflector is much greater, and the downward illumination obtained with well-designed reflectors is much increased. If shades of a decorative kind, which have little directing power, are desired, the advantage of using lamps whose filaments are constructed to give a strong downward component is possibly even greater. From my own experience the life of such filaments appears to be somewhat less, perhaps 20% less, than those of the straight type, but in most cases the cost of replacing lamps is more than counterbalanced by the gain in illumination, and the smaller consumption to produce a given effect.

It will be observed that the distribution of light from many lamps with coiled filaments is radically different from that of the ordinary standard type of lamp—a point that was brought out very clearly in the contribution by Mr. Willcox last March. It is a question what is meant by the "candlepower" usually ascribed to such lamps. The candlepower of an ordinary lamp is usually measured perpendicular to the axis of the straight filament, but even this value bears little relation to the performance of the lamp when the distribution of light has been entirely altered by using a suitable reflector. It is worth the consideration of lamp-manufacturers whether they could not provide a rough polar curve with each lamp sold, the curve being marked on the paper in which the lamp was wrapped.



SECTION. ELEVATION.

~~~~ Corrugated reflector surface.
—— Plain reflector surface.

FIG. 1.—Details of overhead reflectors for platform lighting in the Queen's Hall, People's Palace.

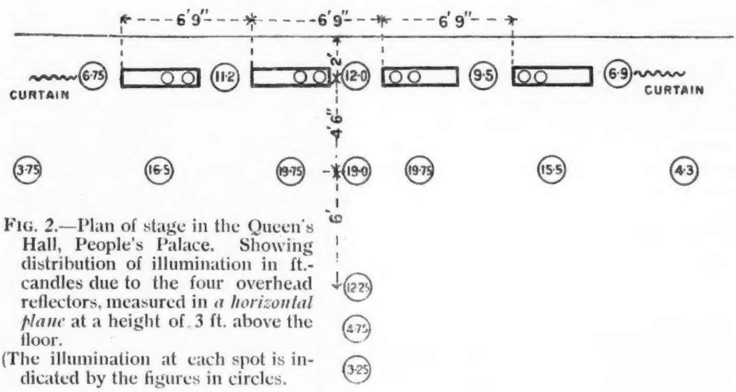


FIG. 2.—Plan of stage in the Queen's Hall, People's Palace. Showing distribution of illumination in ft.-candles due to the four overhead reflectors, measured in *a horizontal plane* at a height of 3 ft. above the floor.
(The illumination at each spot is indicated by the figures in circles.

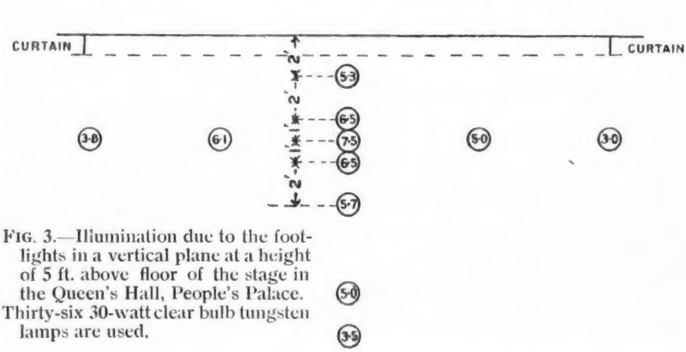


FIG. 3.—Illumination due to the footlights in a vertical plane at a height of 5 ft. above floor of the stage in the Queen's Hall, People's Palace. Thirty-six 30-watt clear bulb tungsten lamps are used.
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No doubt this would mean more trouble, but would give a much more definite idea of the performance of the lamp to the purchaser.

Another point for consideration is the design of reflectors to suit special types of filaments. At present manufacturers appear to design the reflectors to suit the ordinary straight filaments. It is obvious that the position of the filament with regard to the reflector will affect the polar curve of the lighting unit, and it would be a great advantage if makers of lamps and reflectors could co-operate more completely so as to secure that standard and suitable dimensions, for both are adopted. With a straight filament errors due to the position of the filament are probably not very great. But with a filament of the bunched type the polar curve is very different, and a small change in the position of a filament of this kind has much more effect. Those who have used lamps having portions of the filament mounted horizontally know that the distribution curve often varies considerably during the life of a lamp owing to the "sagging" of the filament. The most important factor for most installations is a knowledge of the illumination obtainable 5 or 6 feet below a given unit, consisting of a certain lamp in a specified type of reflector, and it would be a convenience if this could be generally stated.

In what follows I propose to describe a few lighting installations which have been carried out under my supervision at the East London College and elsewhere, and which illustrate the application of lamps having various kinds of filaments, in some cases used with specially designed reflectors.

Figs. 1—6 illustrate the special arrangements made for the lighting of the stage in the Queen's Hall at the People's Palace. The stage receives illumination from footlights and also from four special reflectors, in the design of which Mr. Wise, a member of the Society, rendered valuable assistance. The chief points of interest may be summarised as follows :—

PARTICULARS OF SPECIAL LIGHTING OF STAGE OF QUEEN'S HALL, PEOPLE'S PALACE.

Requirements :—(1) Fifteen feet clear head room. (2) Lights to be entirely invisible to the audience. (3) No light to escape over front of stage, and (4) Lighting units to be supported independently of any other fitting on the stage.

Useful area, 28 feet × 14 feet.

Lighted by 4 units, each consisting of a specially designed reflector containing one 600 watt clear tungsten and one 300 watt clear tungsten lamp. A section and elevation is shown in the accompanying plan (see Fig. 1).

Height of light source, 17 feet above stage.

Resulting illumination shown in detail on accompanying plan (see Fig. 2).

Average, 13 foot-candles.

Maximum, 20 foot-candles.

Minimum, 7 foot-candles.

Reflectors are practically invisible to the audience.

Illumination on a vertical surface is given for the footlights (see Fig. 3).

Photographs of the Hall are also shown.

FIG. 4.—Photograph of portion of stage (Queen's Hall, People's Palace), showing overhead reflectors for platform lighting.

I may mention that the special design of the above mentioned reflectors was made necessary by the fact that only lamps with ordinary filaments occupying a considerable space were available. Had half-watt lamps been available the design might have been simplified.

The next illustration (Fig. 7) shows the electrical engineering laboratory, which is lighted by bunched filament lamps in Holophane reflectors. The original lighting was by means of vertical filament

lamps, but by substituting bunched filament lamps (the lamp in each of the eight fittings being changed from an ordinary 100-watt tungsten to a 60-watt "axial" tungsten lamp), a much better result has been obtained.

The drawing office of the Electrical Engineering Department, East London

FIG. 5.—Queen's Hall, People's Palace, showing effect of general lighting; special overhead platform reflectors *off*.

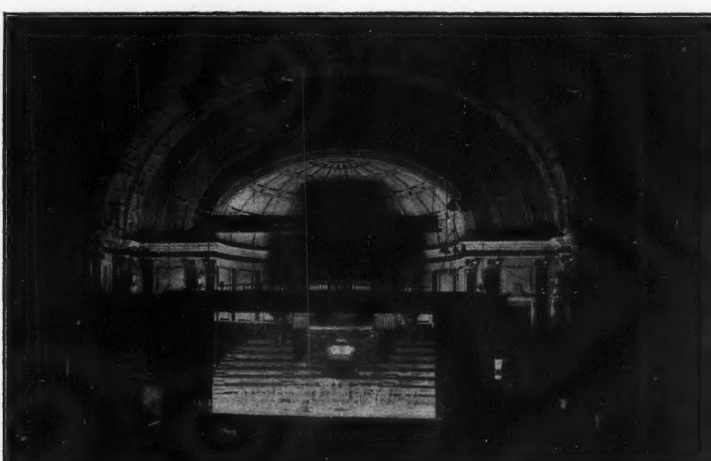


FIG. 6.—Queen's Hall, People's Palace; general lighting *off*. Special overhead platform reflectors and footlights *on*.

College, illustrated in Fig. 8, again shows the use of bunched filament lamps in Holophane reflectors.

The following particulars of this installation serve to show the advantage of this type of lamp :—

PARTICULARS OF LIGHTING OF DRAWING OFFICE, ELECTRICAL ENGINEERING DEPARTMENT, EAST LONDON COLLEGE.

Room measures 42 feet × 24 feet.

Original System of Lighting :—Lighted by twenty 60-watt lamps, with Holophane shades.

Centre of each source of light 7 ft. above tables.

Horizontal illumination in working area, 4·0 to 6·5, with one watt for square foot.

Final System of Lighting :—Altered to spiral filament tungsten lamps and sources raised.

Twenty 40-watt lamps.

Centre of source of light raised to an average of 7 ft. 6 in. above tables.

Horizontal illumination in working area at table height 7·0 to 8·5 foot-candles, with ¾-watt for each square foot.

I have had similar experience in an exceptionally large chemical laboratory where a similar diminution in the consumption was made. In view of these results it is surprising that lamps of the bunched filament type are not more widely used, and that thoroughly appropriate reflectors for use with them are not available.

The final illustration (Fig. 9) shows a specially designed method of lighting a chemical balance. At my suggestion this method has been adopted by Messrs. Gallenkamp, who kindly lent a balance for exhibition at this meeting. A tubular lamp in an appropriate reflector is placed on the top of the balance strongly illuminating the interior. A shallow screen of a white matt material (cardboard or celluloid) near the top of the balance serves to conceal the filament from the observer, and also assists in diffusing the light on to the wider beam. The observer sees the strongly illuminated scale immediately below the lower level of this screen. At the base of the balance there is also an inclined sheet of white cardboard. This serves to reflect light on the marked surface in front of which the pointer attached to the beam oscillates; the observer can thus see at a glance whether or no the beam is in exact balance. In view of the delicacy of the operations carried out on a chemical balance, and the time spent in these operations, a good local illumination from a concealed source is really helpful, and the above method may serve as an instance of how by the choice of the best type of lamp and appropriate screening devices, one can secure exactly the conditions of illumination which the problem demands.

The photograph hardly does justice to the actual condition, since the brilliantly illuminated scale arm was necessarily somewhat over-exposed, and is in reality much brighter than the picture suggests.

In conclusion, I regret that these remarks are somewhat disjointed in character. This is due to the fact that I have been extremely busy on other pressing work during the past months, and, like many other members of the Society, have not had as much time to devote to illumination as I would like. I hope, however, that enough has been said to lead to a useful discussion. I would also like to express my indebtedness to Mr. Mullard for enabling me to exhibit the new lamp with which he is associated and for other information; and to Mr. Dow, the Hon. Asst. Secretary of the Society, by whom the various photographs illustrating this contribution were taken.

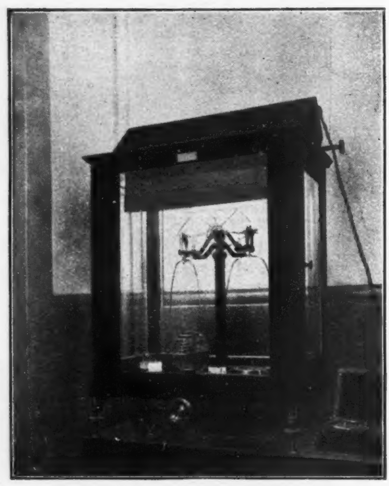


FIG. 9.—Showing special lighting of chemical balance.

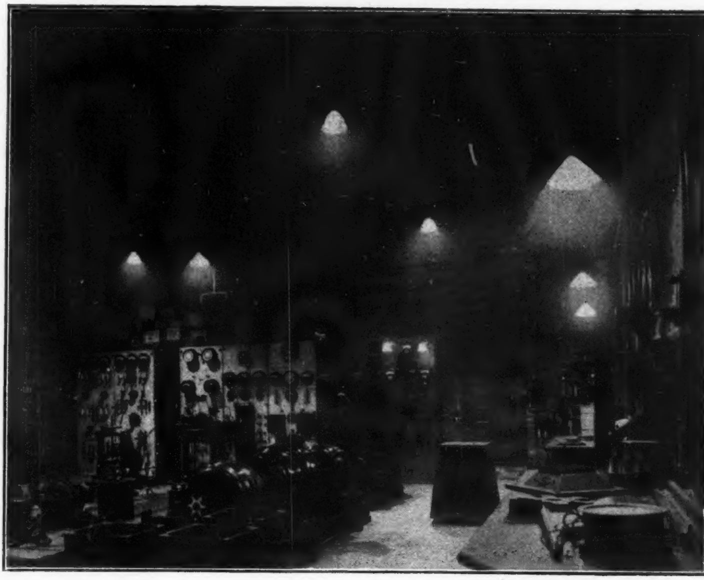


Fig. 7.—Illumination of Electrical Engineering Laboratory, East London College.

FIG. 8.—Illumination of Drawing Office, East London College, by special bunched filament lamps in Holophane reflectors.

DISCUSSION.

Mr. S. R. MULLARD exhibited and demonstrated the arc incandescent lamp referred to by Professor Morris. The ionising rod mentioned by Professor Morris, he said, is a mixture of tungsten and some of the refractory earths.

The type of lamp suitable for continuous current circuits, where about 100 mean spherical candle-power was required, was as shown in Fig. (1). It would be seen that in appearance the new lamp was similar to the ordinary incandescent lamp, the bulb, stem and leads being similar in both types.

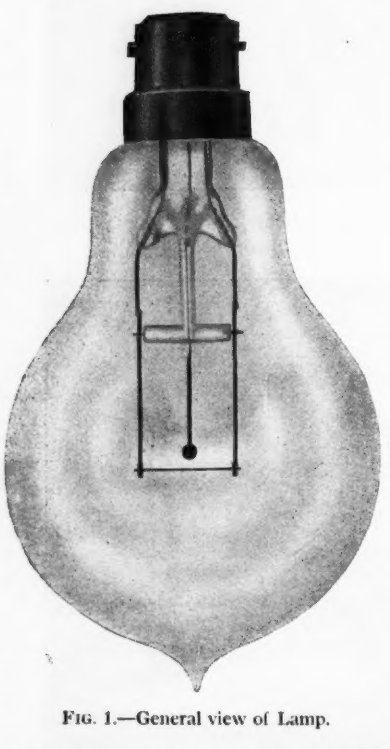


FIG. 1.—General view of Lamp.

The lamp consisted of a nitrogen filled bulb, in which were mounted a spherical tungsten electrode and an ionising rcd. Between the electrode and its stem lead an expansion strip was inserted.

Three leads were necessary through the lamp stem; on one was mounted the spherical electrode, whilst the other two supported the ionising rod. There were three contacts in the lamp cap, which had odd sized pins, and a three plunger lamp holder, having large and small slots, was employed. This prevented wrong connections between lamp holder and lamp cap. Fig (2) showed diagram of connections for the lamp. The positive main lead was divided into two circuits, one passing through the resistance R_1, and the push or normally off switch E. to the one end of the ioniser, the other circuit being through the resistances R_1 R_2 to the electrode A. The negative lead was connected to the other end of the ioniser.

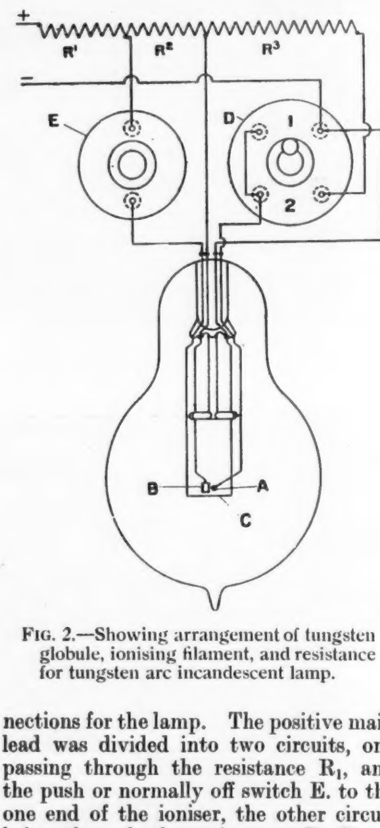


FIG. 2.—Showing arrangement of tungsten globule, ionising filament, and resistance for tungsten arc incandescent lamp.

To start the lamp, the switch E. was depressed, and current passing through the ionising rod caused this to incandesce and ionise the surrounding gas. The switch E. was quickly released, contact only being made for a second or two, and on the ioniser circuit being broken

an arc was struck between the electrode A. as anode and the ionising rod C. as cathode. The heat from the arc caused the expansion strip F. to warp and move the arc to a position further along the ioniser. At this point where the arc was maintained, the ionising properties of the rod were destroyed, but on switching off the current, the expansion strip cooled, and the spherical electrode returned to its original position opposite the still active portion of the ioniser.

By this means the lamp could be started at any period of its life without difficulty. In this lamp practically the whole of the intense white light emanated from the small globule of tungsten A., which was about 1/10-inch in diameter.

For high candle-power lamps, where a larger light giving surface was required, the arrangement was as shown in Fig. (3).

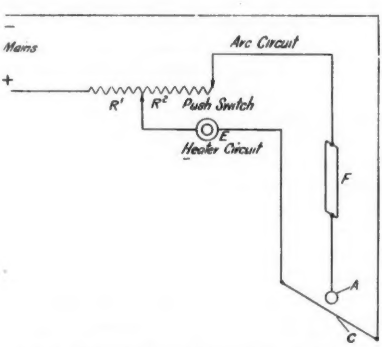


FIG. 3.—Diagram of connections for high c.p. arc incandescent lamp.

In this lamp there were two electrodes, the small spherical electrode A., and a larger flat electrode B., both of fused tungsten. These were set at a definite distance from each other and from the ioniser C.

To start the lamp, the 2-way switch D was made to complete the circuit 2, thus connecting the electrode A. to the positive lead through the resistances R_1 R_2 R_3. On pressing the push or normally off switch E. (which was connected to the positive lead at the end of the resistance R_1) the ioniser C. was made to incandesce sufficiently to ionise the gas between it and the electrode A. Two or three seconds, during which the ioniser was incandescent, was sufficient to accomplish this. Immediately the switch E. was released and the positive lead of the ioniser circuit broken, an arc was struck between the ioniser C. as cathode and the small electrode A. as anode. As soon as the electrode A. became brightly incandescent the switch D. was moved into the position at I. The electrode A., formerly positive, now became negative, and being white hot easily ionised the gap between itself and the plate electrode B. (connected to the positive main lead through the resistances R_1 R_2). An arc was thus struck between the spherical electrode A. as cathode and the plate electrode B. as anode. By these means it would be seen that an arc could be easily struck between substantially large tungsten electrodes, which being properly proportioned ensured the lamp having a long life.

Lamps of this type had been made in the Edison and Swan Laboratory up to 1,200 candle-power.

A spectrum analysis of the light emitted showed continuity and strength in the visible, also an extension into the ultra-violet.

The new lamp was a great advance on the ordinary carbon arc. No regulating mechanism was required and, therefore, the initial cost of production was less. The arc was very stable on varying voltage, and further there was no trouble from flickering or arc wandering. The arc being completely enclosed there was no danger from fire. The light giving surface for the same output was greater than that of the carbon arc, and the loss of light due to obstruction by the electrodes was much smaller.

In comparison with incandescent lamps, the light from the new lamp was much whiter in colour than the ordinary half-watt lamp. The lamp had special applications for all types of projection lanterns, micrography, colour matching, &c., &c.

(For a fuller account of the physical and electrical characteristics of this lamp, see *Journal of the Institution of Electrical Engineers*, Vol. 34, No. 251, Dec. 1st, 1915.)

Mr. F. W. WILLCOX referred to the change in designs and change in character of fittings which the new development in lighting, especially the half-watt lamp had rendered necessary,

but before giving these he would like to say something with regard to Professor Morris's advocacy of the spiralised filament lamp. Professor Morris and himself had exchanged views on this matter before privately, and apparently Professor Morris believed very strongly in this lamp. His own experience in connection with it, however, had been that it would not generally prevail, for the very obvious reason that it was more or less a special lamp. The ordinary vertical filament had the distinct advantage that it was a uniform type of filament for practically all sizes and types of lamps. The straight filament also enabled the bowl form of reflectors to be used more advantageously, and the distribution of the illumination could be insured very much more positively than with such a spiralised concentrated filament form of lamp. As long as the efficiency was not improved the straight filament holds the field. The greater intrinsic brilliancy of the half-watt lamp was justified by the change in the efficiency, but with the spiralised filament vacuum lamp there was no gain in efficiency; indeed, the actual efficiency was lower than for the ordinary lamp. Further, being a spiralised filament it was bound to be much hotter, and consequently the life would be shorter.

He could not understand how it was that Professor Morris had secured a better illumination with 40-watt spiralised filament vacuum lamps than with a 60-watt straight filament vacuum lamp. There could not be a greater total illuminating effect, and he could only explain it on the basis that Professor Morris had merely increased the downward light by the type of reflectors that he used. While it was not possible to increase the total light, it was possible to increase the light in some particular direction. However useful these lamps might be in special cases, they were not lamps which would be universally used as against straight filaments because of the extra cost, shorter life, and other disadvantages such as their extreme brilliancy, which made them difficult to use under ordinary conditions. If, however, there was some gain in efficiency as in the half-watt lamp, then the change in the type of filament was justified, and this brought him to the subject of his notes dealing with the changes which the half-watt lamp had brought about in reflector and fitting design.

It was fortunate from the illuminating engineering standpoint that the new half-watt lamps had all the qualities which rendered ordinary incandescent lamps the most convenient type of lamp to manipulate.

These advantages might be summarised as follows :—

(A) There are no moving parts or mechanism, and the half-watt lamp neither requires nor permits adjustment.

(B) The half-watt lamp is supplied and used as a complete article without separate parts.

(C) The half-watt lamp is equally satisfactory on either alternating or continuous current service, and for series or multiple operation.

(D) The half-watt lamp is serviceable on all frequencies of alternating current down to and including 25 cycles.

(E) The half-watt lamp is a non-inductive load (power factor 100 per cent.).

(F) The half-watt lamp is available for any voltage from 25 volts to 260 volts.

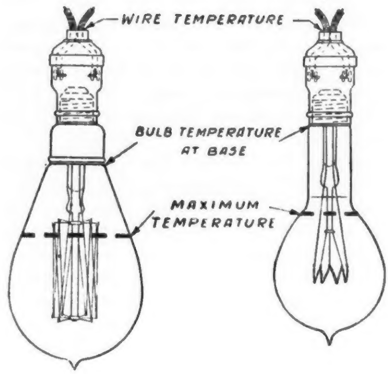
(G) The half-watt lamp is made in a complete range of sizes, from 15 watts to 1,500 watts, permitting the use of a number of distributed lights in place of large arc light units of equivalent candle-power, a condition securing the ideal for uniform lighting.

(H) The half-watt lamp can readily be adapted in reflectors of suitable design to secure any desired distribution or concentration of light, especially in the lower hemisphere, and the filament of the lamp is shaped so as to materially promote this feature.

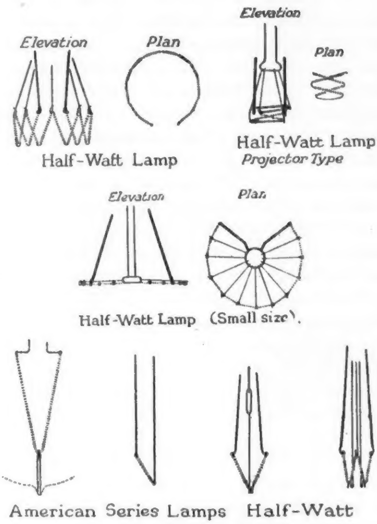
(I) The light of the half-watt lamp is steady, soft, uniform, and of a most brilliant quality and satisfactory colour.

(J) The half-watt lamp is silent, simple, and reliable, and relatively to other high candle-power lamps is inexpensive in investment or first cost.

The introduction of the new half-watt tungsten lamps will compel a radical change from the old lighting methods. The very high intrinsic brilliancy of these lamps (some eight-fold greater than that of the ordinary tungsten lamp) will enforce proper methods of obscuring and diffusing the light, as the light in general



Showing distribution of temperature in ordinary (vacuum) tungsten lamps and half-watt (gas filled) lamps.



Types of half-watt lamp filaments.

TABLE, COMPARING TEMPERATURES DEVELOPED IN ORDINARY TUNGSTEN AND GAS FILLED ("HALF-WATT") LAMPS, AS DETERMINED IN THE ENGINEERING DEPARTMENT, NATIONAL LAMP WORKS, U.S.A.

Lamp Wattage.	Minimum Bulb Temperature in Degrees Fahrenheit. Room 70°.	Bulb Temperature at Cap in Degrees Fahrenheit. Room 70°.	Type of Lamp Holder, and Wire Temperature in Degrees Fahrenheit. Room 70°.
Metal Filament Lamps :—			
Vacuum Type :—			
100	152	105	Standard brass E.S. holder.
150	157	120	Brass holder.
250	245	140	Brass holder.
"Half-watt" Type :—			
100	223	110	Standard brass E.S. holder.
200	265	150	Brass holder.
300	260	104	Porcelain Goliath holder.
400	327	164	Do.
500	360	175	Do.
750	317	170	Do.
1000	353	190	Do.

is too painful to be used exposed in the objectionable and harmful way in which the ordinary tungsten lamps are so frequently employed. In a sense, therefore, the new half-watt lamps will prove an excellent aid to the cause of illuminating engineering and good lighting methods. We have at last come to a type of incandescent lamp which does not permit being substituted for existing lamps in the old style fittings and reflectors as the ordinary tungsten lamp was, when it replaced the carbon lamp. There will, therefore, be a very radical change from the old methods and existing antiquated types of shades and appliances, and the substitution therefor of new scientific equipment, designed for use with these latest lamps.

The large gains in efficiency secured by these new lamps will of necessity cause their very wide adoption, particularly in industrial plants. We are therefore face to face with a revolution in lighting appliances and methods. These can in general be stated as follows :—

(A) The raising of the plane of illumination to 10 or 12 feet above the working plane—thus approaching more equally daylight conditions, by the employment largely of general illumination instead of purely local illumination with the old methods of drop cords or hand lamps.

(B) The obsolescence of the ordinary arm fitting or electrolier or chandelier, which is a relic of the old gas or oil flame days. The art of illumination will thus be freed from the trail of the fittings industry with its large masses of metal in more or less inartistic groupings of arms and branches, and the opportunity given of substituting the more pleasing and beautiful form of bowls or spheres or dishes and urns of alabaster or attractive diffusing glass ware.

(C) The obsolescence of the old ordinary conic opal (open mouth) shade. This particular appliance is the *bete noir* of illuminating work throughout Great Britain, and the half-watt lamp is conferring a blessing of marked degree in banishing this uncouth, inefficient appliance which obstructs and mars the inside of most of the offices and public buildings and other interiors in Great Britain.

(D) The adoption of some form of bowl or dish fitting of translucent glass (semi-indirect lighting) or an opaque bowl (indirect lighting) to distribute and diffuse the light and screen the direct rays. The beauty, comfort, and general agreeableness and effectiveness of indirect and semi-indirect lighting becomes generally available through the high efficiency and volume of light, of these new half-watt lamps. In brief, the half-watt lamp enables us to approach the daylight conditions by the wider employment of that general illumination which indirect and semi-indirect lighting gives.

(E) As the half-watt lamp is employed in large sizes, 100 watt and over, and is more efficient in the still larger sizes of 300 watt and over, there will be a tendency to eliminate "cluster lighting," groups of small lamps, the arm fitting, &c., which will be replaced by a single lamp of suitable size in the proper design of equipment of bowl or dish.

(F) Furthermore, the ordinary open flame arc lamp and enclosed arc lamps to a great extent will be supplanted by the new half-watt lamp, owing to the decided advantages of simplicity, general adaptability and freedom from care and attention which the half-watt lamp secures.

Certain specific changes in design have been occasioned by the coming of the half-watt lamps, namely :—

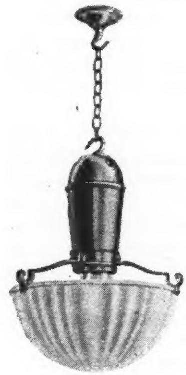
(1) The greater concentration of the light-source in the form of a more compact filament, subtending a much smaller vertical angle than the ordinary filament, requires that :—

(A) Greater care and skill must be expended on the design of reflecting surfaces in order to ensure that the desired distribution curve is obtained.

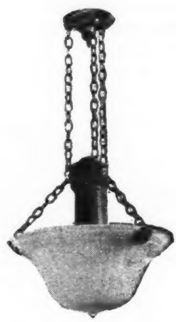
(B) The position of the filament with regard to the reflector needs to be determined more accurately than in the case of an ordinary filament as a slight displacement up or down makes a much greater difference ; to meet this requirement an adjustment enabling the lamp to be moved up and down to its correct position is needed and is embodied in modern types of reflectors.

(2) The heat generated in the half-watt lamp is exceptionally great, partly owing to the larger volume of energy concentrated in a given space, and partly to the fact that the gaseous contents of the bulb conduct the heat very readily to sur-

(a) Types of old fashioned fittings which the half-watt lamp has caused to be superseded by improved scientific designs of fittings, such as the following.

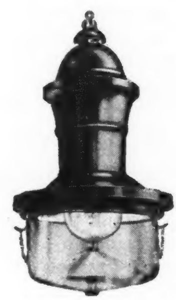


Semi-indirect fitting. Indirect lighting fitting.



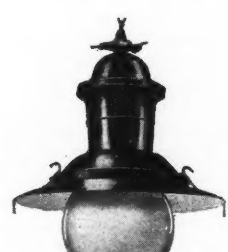
(b) Ball fitting with over reflector.

Semi-indirect fitting with ornamental bowl.



Street Lighting fitting.

(c) Sphere fitting. Semi-indirect fitting.



Weatherproof Lantern.

A FEW EXAMPLES OF MODERN FITTINGS FOR HALF-WATT LAMPS.

(Mr. F. W. Willcox).

rounding objects. Special provision must therefore be made for ventilation, and the wiring must be carried out with heat-proof insulation. The concentration of heat at the neck of the bulb makes it imperative that all outdoor fittings should be weatherproof, as well as adequately ventilated.

(3) As a general rule half-watt lamps must be burned in a pendant position, and fittings must be designed accordingly. (An exception may be made in the case of some of the smaller sizes which utilise filaments shaped in a horizontally situated ring; these may be burned upside down).

(4) The concentration of light in a smaller filament has increased the difficulties of design in certain types of reflectors. An instance is afforded by the special extensive reflectors designed for street lighting; it is very difficult to design a suitable reflector of this kind for the half-watt lamp, and recourse must be had to the use of a deflector under the filament or to a special refracting globe (such as the Holophane refractor) in order to secure the high component at a small angle below the horizontal.

(5) The greater concentration of filament, besides making shading necessary in order to diminish the high intrinsic brilliancy, also gives rise to harsher shadows; for this reason also suitable methods of diffusing the light are needed.

The design of lighting units to comply with all these requirements is no easy matter. In general the increased efficiency of the half-watt lamp should result in a diminution in the size and bulk of the fitting for a given output of light. In particular it should be noted that the development of this type of lamp means a new era in illumination, and must give rise to new methods. Just as "new wine cannot be put into old bottles," so these new lamps cannot be effectually used with old types of fittings. New units are being introduced, and the methods employed in lighting various classes of interiors must undergo considerable modification. At the present time, when the publication of the Home Office Report on Factory Lighting has emphasised the economic and hygienic value of good illumination, these new appliances should be a valued weapon in the hands of the illuminating engineer.

Mr. W. R. Cooper expressed the hope that Mr. Mullard would be able to give a few more particulars of his lamp, and some further statement of the advantages as compared with the ordinary incandescent lamp. The latter required stating a little more fully because it was a more complicated lamp; he would like to know, for instance, how high the candlepower could go, and what the life was likely to be. Intrinsic brilliancy was a difficulty in gas filled lamps. Would it be possible to include a reflector of unglazed porcelain above the filament in the bulb without seriously interfering with the maintenance of a good vacuum? If so, this would give relief. A polar diagram of a lamp by itself would be of very little value because lamps are always used with reflectors.

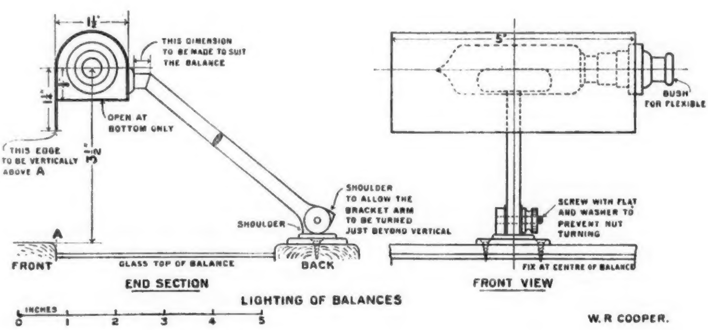
Probably the proper course would be for the makers to develop certain reflectors which they considered satisfactory, and to supply polar diagrams of the lamp and reflector. In that way people would know what they were getting, and the sort of shade they should use.

He was interested in Professor Morris's remarks as to platform lighting, and particularly in regard to balance lighting. He himself had recently designed a fitting for lighting chemical balances, and this appeared to him simpler than Professor Morris's method. As seen by the accompanying drawing a small tubular lamp (which might have to be a carbon lamp for the higher voltages) was used in a metal shade. The shade was closed at either end, and was carried down a certain distance in front so as to screen the lamp entirely from the eyes. The shade was conveniently made of bright lacquered brass, and one end of it carried the lamp holder. Since heating of the balance must be avoided in accurate work the shade was carried by a bracket at the height shown, and might be ventilated. The bracket was hinged so that it could be thrown back and thus cause no obstruction to daylight working. By having the shade in the position indicated perfect illumination was obtained of both the beam and the lower scale without the necessity of any reflecting surfaces within the balance case. He thought it was undesirable to introduce such reflectors if they could be avoided.

Mr. A. CUNNINGTON (L. & S.W. Railway Co.) said he had hoped that Professor Morris would have given more particulars in connection with half-watt lamps, such as mean spherical candle-power and candle-power in certain directions. Possibly a polar curve might be of use although as Mr. Cooper had pointed out it would not be of much value if it only referred to the lamp and not to the reflectors. There seemed to be much doubt as to exactly what candle-power was referred to in rating half-watt lamps. He would like to know if the efficiency of 0 65 watts per candle for the half-watt lamp in the table shown by Prof. Morris was based on the mean spherical candle-power, the mean hemispherical, the vertical or the horizontal. Another point was the question of under-running half-watt lamps. The relationship between voltage and life was said to be such that very slightly over-running the lamps considerably shortened the life, and in actual practice he had found this to be so. Owing to fluctuations of voltage, certain lamps under his control had had to be renewed very frequently, the reason being the close proximity of an anti-aircraft searchlight installation which had caused the pressure of supply to be very erratic. With half-watt lamps one could not afford to look upon cost of current as the only thing of importance. Maintenance was a very serious matter when each lamp cost a sovereign, and in order to guard against the loss of a lamp through a temporary rise in voltage, it appeared to be worth while actually to under-run slightly even if the maximum efficiency was not obtained. There was obviously a theoretical point of maximum economy in the running of lamps, with a given price for current and renewals, and possibly Prof. Morris could throw some light on this subject.

Mr. E. STROUD said he had listened to Professor Morris's remarks with great interest.

He failed to see the advantages of lamps with their filaments so designed as to throw the light downwards without the aid of a reflector, as, whilst this form of lamp gives a greater candlepower than the straight form of filament directly under the lamp, it must of necessity give a corresponding value directly above, which to a great extent cannot be collected by reflectors and utilised in an efficient manner, being lost in lamp-cap and fitting.



LIGHTING OF BALANCES

It is generally agreed that one must use some form of reflector with any lamp to obtain maximum efficiency and avoidance of glare, and the best form of filament is one which enables the reflector to collect the majority of the rays above the 60 degree zone, which otherwise would be wastefully employed.

Professor Morris also stated that the new spiral wound filaments similar to the "half-watt" types altered the characteristic distribution of existing reflectors now on the market. This is not the case (at least with Holophane Reflectors), as with the smaller size of filaments the curves with the reflectors are accentuated

to a marked degree, but are not altered in general character. That is to say an E, I or F type of reflector remains of the same type, and the spacing is unaltered.

As light sources get more concentrated (or smaller) so will it be possible to get still more efficient reflection with prismatic glassware.

To get these curves one must necessarily make suitable modifications in holders and galleries, and insure the correct position being taken up by filament to reflector. He quite agreed with Mr. Willcox that the position of the filament in relation to the reflector with the new form of winding is of much greater importance than it was with the old straight type. Any steps that could be taken in the direction of standardising lamps so as to make the position of the filaments uniform would be a great advantage.

Mr. Willcox mentioned that the smaller sizes of bulbs in half-watt lamps enabled smaller reflectors to be used. This is so to a degree, but it must not be carried too far, as it has to be remembered that the intrinsic brilliancy might be undesirably high, and he thought with the half-watt lamp this factor would have quite an important influence on the size of the unit. The very high value (upwards of 5000 c.p. per square inch) for this intrinsic brilliancy showed how very necessary it was to use suitable reflectors with lamps of this kind.

Mr. Leon Gaster said that the greater range of candlepower and varied distribution of light from incandescent lamps afforded new opportunities to the illuminating engineer, and made it important that their illuminating power should be accurately specified. At a discussion on this subject at the meeting held in March, 1915, the view had been expressed that the mean spherical candlepower should also be stated. This view was being taken up by leading Continental lampmakers. For example, he noticed that a two-page announcement, now being issued with regard to a new type of small candlepower gas-filled lamp laid stress on the uncertainties caused by existing methods of stating candlepower, and announced the intention of stating, beside the watts, also the mean spherical candlepower in future. On the second page of the announcement the following particulars, among others, were given :—

Voltage.	Watts.	Mean spherical C.P. (approx. H.K.)	C.P. in an axial direction (approx. H.K.)
100—130	40	45	55
	60	70	85
	75	90	110
	100	130	160
200—250	75	80	100
	100	110	140

This is in accordance with the practice largely adopted in Germany to mark the voltage and watts on the lamp, and to give in the literature also the approximate mean spherical and the horizontal candlepower.

The invention of the gas-filled lamp was doubtless an important step forward, and it was interesting to observe the transition from lamps of high candlepower and low voltage to low candlepower and high voltage, just as took place in the case of the ordinary tungsten lamp. He hoped, however, that manufacturers would exercise restraint in this matter, and not unduly push forward with the low candlepower high voltage units until an adequate life was obtainable. In his experience the life of these units was less satisfactory than that of the larger types ; in cases where a very low rate for electricity could be obtained there was little advantage in using half-watt lamps unless a life of at least 600 hours was attained, otherwise the cost of maintenance might be too high to enable any economy to be made. It must also be remembered that when comparatively large lighting units are employed the sudden extinction of a lamp illuminating a large section of a room was often highly inconvenient, especially where delicate manufacturing operations were in progress.

The question had been raised whether lamps with specially designed filaments intended to give different light distribution should not be more widely used. He was inclined to think that a better solution of the problem was to rely on the variety of reflectors now available for the purpose of modifying the distribution

of light according to the local circumstances, and to aim at the production of a standard type of lamp, which could be gradually perfected and cheapened by manufacturers.

The recent development in lamps also made it necessary for the public to receive guidance. It was essential for lampmakers and manufacturers of reflectors to work together, so that the lamp and its appropriate reflectors became regarded as " one unit," and both were used to the best advantage.

In this connection it might be remarked, as a matter of history, that to his knowledge the Holophane Co. was the first in this country to establish an illuminating engineering department, and to publish in their catalogues distribution curves of the various types of reflectors made by them, and to give advice regarding their use. During the last few years several of the leading companies have developed illuminating engineering departments, and are doing good work in helping the public to obtain scientific illumination. Progress in this respect was in a great measure due to the development of the movement in this country, which had been steadily educating the public to appreciate the claims of good illumination, and to recognise the need for discrimination in the selection of illuminants and the proper appliances for use with them.

As an instance of the recent advance in lighting values it was interesting to quote some figures given by Mr. P. S. Millar before the Illuminating Engineering Society in the United States in 1913 :—

Year.	Approx. average C.P. of all incandescent lamps sold.
1906	18
1907	19
1908	21
1909	23
1910	25
1911	26
1912	29
1913 (estd.)	32

These figures showed very clearly that the standard of illumination during the period 1906-13 had almost doubled, and it was interesting to observe that the illuminating engineering movement in the States was initiated in 1906, and had since largely influenced the progress of lighting in that country.

There was no doubt that meetings of the Society, by making clearer the requirements in connection with various problems in illumination (such as the lighting of schools, libraries, and factories and workshops of various kinds), and by bringing about general agreement as to the chief qualities desirable in globes, shades, and reflectors, had given a great stimulus to the efforts of manufacturers and had brought about a more discerning attitude on the part of the general public. Many of the improvements of recent years were to be traced to the discussions at meetings of the Society.

He observed that within the last few months companies had taken advantage of the issue of the Home Office Departmental Committee's Report on Factory Lighting to offer the services of their illuminating engineering departments to the public in planning lighting installations in factories. But it must be agreed that those who wished to assist the public should themselves be kept fully informed of the latest advances in the subject, and in this respect the platform of the Illuminating Engineering Society in this country was undoubtedly of great value to those concerned with illumination.

Finally, Mr. Gaster said that he wished to associate himself with other speakers in congratulating Mr. Gimingham and Mr. Mullard on the new lamp shown that night for the first time, which appeared to have some interesting possible applications.

Mr. J. S. Dow (*communicated*): I was much interested in the new lamp described by Mr. Mullard. Some time ago I made some experiments in conjunction with Mr. Mackinney, on a suggested form of projection arrangement for small lanterns in which the condenser was replaced by an elliptical mirror. It was hoped by this means to improve on the enormous inefficiency of the ordinary method of projection. A small incandescent lamp was placed at one focus of the mirror, the idea being that every ray reflected from the mirror should be collected on the objective lens, which was placed at the other focus, the lantern slide being situated between the foci. The arrangement did not answer for the existing form of filament chiefly

because this did not approach sufficiently near to a point, with the result that the rays were not satisfactorily concentrated at the second focus and no great gain in efficiency was secured. But with such an incandescent source as that shown by Mr. Mullard the principle might be worth a second trial.

With regard to the figure for the intrinsic brilliancy of the half-watt lamp it is somewhat of a surprise to find this so high. The ratio between the intrinsic brilliancies of the ordinary tungsten and the carbon filament lamp is about the same as the ratio between their efficiencies. Seeing that the efficiency of the half-watt lamp is stated to be about twice that of the ordinary tungsten filament, one would have anticipated an intrinsic brilliancy of about 2,000 candles per square inch. Even if there is a certain loss by convection and conduction of heat owing to the gaseous atmosphere round the filament it seems rather difficult to account for this seeming discrepancy.

The CHAIRMAN, in winding up the discussion, said that the first slide which had been put upon the screen by Professor Morris gave an exceedingly interesting historical review, but it did not state what he believed was the absolute truth, namely, that nearly all progress with electric lamps was due to the indisputable circumstance that electricity had to compete with gas. The discoveries in connection with each system of lighting had given a stimulus to the other. It was the discovery of the principle of the incandescent mantle by Auer von Welsbach, in Austria, a generation ago, which improved gas lighting to such an extent that electric lighting was bound to follow suit or be displaced.

The historical table began with the lamp associated with the names of Edison and Swan. This, however, should be Swan and Edison, for did not Swan show an incandescent carbon lamp at work at a lecture given in Newcastle on December 18th, 1878, before any other had been shown? And was it not shown subsequently in the very room in which this meeting was being held, where also so many new things had been shown for the first time in London, many years ago? Indeed, that particular lamp was on view this evening.

Many years after the carbon lamp had been improved, Nernst brought out that stick of glorified pipe-clay, which he made into the Nernst filament. In that he was indebted unquestionably to Auer von Welsbach, because Auer used in his mantles, but in different proportions, the very same rare earth which were afterwards applied by Nernst in his filaments.

Then came the next invention in electric lighting, namely, the Osmium lamp, utilising a very rare metal again introduced by Auer von Welsbach, a metal whose rarity soon compelled inventors to seek for other materials. This no doubt led to the suggestion that tantalum should be used, although it was not originally so good as osmium; and afterwards came the tungsten lamp. A few years ago much was heard of other materials, such as those introduced into the zirconium lamp, but little was heard of this material to-day. He did not see, however, why molybdenum, or an alloy of this metal with tungsten, which is closely resembled, should not be used. It was quite possible that there were other metals which had not yet been fully exploited, and might be utilised in the near future.

The original Swan lamps were sold at a guinea apiece; they eventually came down to somewhere in the neighbourhood of 5½d. or 6d. That was a good long drop, and he was wondering when the tungsten lamp would fall to anything like that figure. At present he had to pay 2s. 2d. for a tungsten lamp, which could not possibly cost nearly as much as that to manufacture, and he was looking forward to the time when the cost to the user would be something like 8d. or 9d. A little competition would perhaps hasten this result. The cost of the half-watt lamps was in the neighbourhood of £1; but here again he hoped that the time was not far distant when the price would fall to a value that could more readily be paid by the humble citizen. What the cost of the newest lamp Mr. Mullard had shown he supposed was not known as yet.

Those present had heard incidentally of problems in connection with the photometry of some of these specially shaped filaments, and the question had been

raised as to whether the candlepower should be expressed in terms of the horizontal, mean lower hemi-spherical, or mean spherical value. No one, so far as he recalled, had suggested that the exceedingly simple method of obtaining the mean spherical candlepower through the agency of the Ulbricht Globe, or some similar chamber with white walls, which could be used for the purpose.

Returning to the lamp shown by Mr. Mullard, he was much struck by the novelty of the principle employed, which was exceedingly interesting from a scientific point of view; he felt confident that the research would not be allowed to remain as a laboratory experiment, but would be carried to a commercial stage. Was it not possible that they had that evening witnessed a historical event? Those gentlemen who were present at the lecture delivered by the late Sir Joseph Swan at Newcastle in 1878, must have felt afterwards that they had witnessed the actual making of history. Possibly those now present would have a similar experience.

In conclusion, he had much pleasure in proposing a hearty vote of thanks to Professor Morris for his exceedingly interesting introduction to the discussion; to Mr. Mullard for having enabled the meeting to see this new lamp, now for the first time shown in public; and to Mr. Willcox for the very helpful observations he had made, especially in regard to the far-reaching and revolutionary changes being brought about by the half-watt lamp.

Professor J. T. Morris (in reply):—I am quite in agreement with Mr. Willcox as to the importance of the exact position of the shade with regard to the lamp; it was in fact a point to which I had directed attention in the short synopsis circulated before the meeting. I was glad to learn from him that some manufacturers are giving this matter especial attention. With regard, however, to the ideal distribution of light from a lamp, surely this is better done, as far as possible in the first instance, by a proper disposition of the filament, for it is obvious that whenever light has to be redirected by a shade or reflector some must inevitably be lost.

Mr. Willcox made much of the half-watt lamp and a new series of reflectors designed for use with it. One cannot but admire the skill which has been brought to bear in the design and production of these reflectors. We must not, however, forget—as Mr. Gaster, Mr. Cunnington, and others pointed out—that unless experience shows that a reasonable length of life can be expected from half-watt lamps the result in the long run will be far from proving a commercial success, owing to the high cost of lamp renewals.

Mr. Willcox seemed sceptical as to my results obtained by the change from straight filament to spiral filament tungsten lamps of the vacuum type. I can only assure him that these results have been obtained under commercial conditions over a period of nearly two years, and relate to some two or three hundred points.

I was much interested in Mr. Cooper's arrangement for lighting a chemical balance, which certainly possesses the advantage of flexibility. It is, however, open to the objection that it is a special device, whereas in my arrangement both lamp and bracket are stock articles and simply laid on the top of the balance; the lamp used also has a metal filament, and therefore for the same candlepower does not give out so much heat. There is also the further objection that in the case of my balance Mr. Cooper's arrangement would be inapplicable owing to obstruction from the woodwork on the top of the balance.

In reply to Mr. Cunnington's question, the results for the half-watt lamp (1,490 watts), given in Table II., are based on the horizontal candlepower, and yield an efficiency of 0·58 w/cp.

Mr. Cunnington suggested that it might be economical to under run half-watt lamps; and in this I am inclined to agree with him, and especially in the case of the higher voltage low candlepower lamps.

The experience which I have had tends to confirm Mr. Stroud's opinion that the alteration in the polar curve of light distribution in changing to the spiral tungsten (excluding the half-watt) lamp, though inappreciable, is not serious if the lamps are sufficiently closely spaced.

On the whole, the views expressed by the various contributors to the discussion have confirmed me in the belief that tungsten lamps of the vacuum type, which

mainly send their rays downwards should be more widely used in cases, of which there are many, in which a horizontal surface has to be lighted. Also with regard to half-watt lamps, though these are satisfactory when in large sizes and used with suitable fittings, they should be used in the smaller sizes with caution until greater reliability in their performance is obtainable.

In view of Dr. Silvanus Thompson's remarks I have added some particulars of Osmium lamps to the tables so as to render them more complete. I should like also to express my appreciation of his kindness in presiding on this occasion.

OVERHEAD SHOP LIGHTING.

THE illustration below was sent us some time ago by Mr. J. L. Stair, of the National X-Ray Co., of Chicago. It illustrates the value of lighting shops on the overhead system, so that, in spite of the presence of a considerable amount of belting, the space is left clear, and the distribution of a strong general illumination enables all the details of the

machinery to be clearly seem. In this case the effect of the opaque reflectors on the ceiling is evidently assisted by the white walls.

The room is 116 ft. long, 50 ft. wide and 13 ft. high and is lighted by 40 100-watt lamps in Bee Hive reflectors spaced 10 ft. apart and 9 ft. above benches. Formerly the room was lighted by a combination of arc lamps and local lights, each bench having three small 16 c.p. lamps.

Now the ceiling lighting does everything that is required and there is said to be a considerable saving of time owing to the fact that the workman is no longer obliged to adjust his lamps to every new position he assumes, as was formerly the case.

While ceiling lighting on this principle is conducive to a good general illumination, it is also applicable in cases of "localised general" lighting when it is desired to concentrate more light at some points than others owing to the presence of particular machinery; the desired accentuation of illumination at certain points is readily accomplished by using a higher candlepower lamp at that spot.

SHORT NOTES ON ILLUMINATING ENGINEERING.

WAR LIGHTING.

(From a recent issue of *The Gas World.*)

STREET lighting in Glasgow is to be reduced to not more than 60 per cent. of what it is at normal times, in accordance with an order issued by the military authorities. The order also applies to shop-front lighting, &c.

Complaints of insufficient street lighting were made at a meeting of the Huddersfield Town Council on the 20th inst. Mr. R. Mitchell, Chairman of the Gas Committee, in reply, said that it had been decided that every other lamp should be lighted and those at street corners wherever possible. He thought, however, if economy was intended, it was false economy. If it were a precaution against air raids, it was futile. The only way to provide against air raids was to extinguish all the lamps. The Mayor said the saving of coal was a great consideration, and the Council had no business to waste anything at present.

The Car-luke sub-committee of the Upper Ward District Committee of the Lanark County Council have refused to take the advice of the Committee and reduce the public lighting for the sake of economy.

Liverpool is at present lighted by the following lamps:—Incandescent gas, 12,513; flat-flame, 2,677; electric, 551; and oil, 93. This shows a large reduction, due to the decision of the Lighting Committee to fall in with the suggestion of the Government to curtail the street lighting with a view of effecting economies. The number of gas lamps not lighted are:—Old city, 4,329; surburban areas, 2,879; total, 7,208. The whole of the electric arc lighting has been discontinued at the request of the Mersey defence authority. The number of electric lamps has fallen from 1,129 last year to 551.

In Macclesfield, as in so many other towns, there are complaints about the want of light in the streets. There was a discussion on this matter (without any result) at the last meeting of the Council. A member expressed the opinion of many others in saying that they were certainly not carrying out anything that would prevent a raid, and were causing themselves a lot of inconvenience and trouble. Another declared that if the restriction was carried out for the purpose of saving expense, then it was a foolish saving.

ERRATA.

We observe that through a clerical error the name of Mr. W. F. Little (who co-operated with Dr. Clayton H. Sharp in a paper on a Compensated Test Plate for Illumination Photometers read at the recent Convention) was incorrectly given as "Mr. T. J. Litle" on p. 444 in the *IlluminatingEngineer* for November 1915.

With reference to the note on a Series of Lectures on Illuminating Engineering on p. 457 in the same issue, we now understand that the University of Philadelphia has invited the American Illuminating Engineering Society to hold the course of lectures at that institution.

SEARCHLIGHTS FOR THE ILLUMINATION OF BATHING PLACES

For several years the authorities in Chicago have been trying to promote the use of the 22 miles of frontage on Lake Michigan for recreation, and it is largely used in the season for bathing.

There are, however, many people in Chicago who can only get free from their business at night time—in fact, fully 90 per cent. of the patrons of these bathing places are engaged until after 5 o'clock or later, so that they can only make use of the beaches about dusk. Several accidents have occurred which could probably have been prevented in the day-time. Moreover, there has been a tendency for the rowdy element in the population to behave in a disorderly manner under cover of darkness.

According to the *Electrical Review and Western Electrician*, experiments are now being made with artificial illumination, so that the beach can be used with the same facility as in the day. At present it has been found practicable to illuminate sections of the beach with projection arc lamps, whose position was so selected that sands and water are flooded with a soft light and there is practically no glare. It is believed that this method will be used regularly on the beaches next summer. It is possible, however, that gas filled incandescent lamps will be substituted for the arcs.

NIGHT ILLUMINATION OF A SWIMMING POOL.

The Delmar Swimming Pool at St. Louis has recently been illuminated artificially by electric light and the installation was described in the *Electrical World*. Five hundred watt lamps (tungsten) are suspended on cables hung across the pool. This pool is very popular during the summer and the new lamps have been receiving a great deal of attention. Swimming during the night time is becoming quite a popular pastime.

STANDARDISING POCKET LAMPS.

We note that the *Elektrotechnische Zeitschrift* for May 27th contains an article discussing the standardisation of small pocket lamps. The figures given for the life of such appliances, which depend on the capacity of the battery, are often very vague.

In order to define this more precisely it is suggested that the life of a pocket battery should be defined as the time during which a discharge of 0·2 amp. through the lamp reduces the voltage of the battery from 4·5 to 1·8. After this the battery must be renewed though in an emergency it might be possible to carry the discharge down to 1·5 volts. If the lamp is only used intermittently, for short flashes, the life would probably be 50 per cent. greater.

INVISIBLE SANDBAGS.

On other occasions we have mentioned instances of the important rôle played by the visibility of distant objects in the present war. For example, the question of designing uniforms of soldiers so as to be as inconspicuous as possible has been discussed, and it is well known that ships and forts are painted in a special manner in order to render them indistinguishable at a distance.

Another interesting example was quoted in a recent issue of the *Times*. An officer at the Front draws attention to the way the sandbags were arranged in the German trenches. It appears that the Germans have adopted the device of using a few dark coloured sandbags at intervals among the lighter ones, so as to produce a sort of patchwork. As a result it is quite difficult to determine their loopholes. A man may fire away at a supposed loophole for hours, only to discover that he has been wasting ammunition on a sandbag.

It has also been suggested that the explanation of these variegated colours lies in the fact that the Germans are short of the materials ordinarily used for making sandbags. However this may be, it would appear from the above experience that the use of this patchwork device is a happy one, and might lead to the saving of a great many lives in the course of a campaign.

THE DEVELOPMENT OF ELECTRIC INCANDESCENT LAMPS FROM 1908 TO 1914.

A RECENT article by X. Remy in the *Bulletin* of the *Association Suisse des Electriciens* (No. 12, December 1915), contains some notes on the testing and rating of electric incandescent lamps. Of special interest is the diagram, reproduced herewith, showing the life of lamps, as determined at the Testing Station of the Association Suisse des Electriciens, and published at the Exhibition in Berne in 1914.

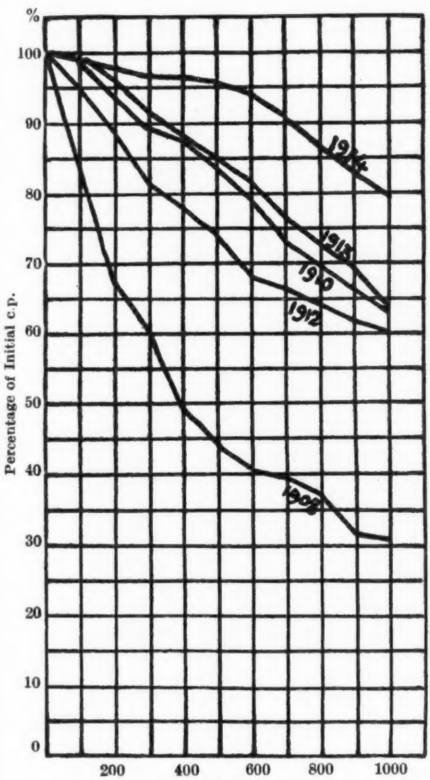


FIG. 1.—Comparison of life of metal filament lamps during the years 1908—1914.

Considerable progress was made from 1908 to 1910, but until 1913 no further great advance was made. After this year, however, the introduction of drawn tungsten wire in place of squirted filaments led to a distinct improvement, as shown by the 1914 curve. It is stated that 80 per cent. of the present lamps attain a life of not less than 1,000 hours.

The author also discusses the development of special forms of lamps, concentrating the light in particular directions. He gives a series of diagrams illustrating the variation met with in distribution of light. On the whole, he thinks that the development of special filaments of this kind is hardly worth while, seeing that in any case they must be used with appropriate reflectors. Consequently it seems unnecessary to shape the filaments with a view to producing special polar curves of light-distribution, and it seems better to adopt a uniform type of filament and to rely on the reflectors to produce any particular direction of light that may be needed in practice. The adoption of a standard form of filament enables makers to concentrate on this model, and thus to bring it to a greater stage of uniformity and perfection.

However, seeing that such variations exist, and that further diversity in distribution of light is introduced in the new "half-watt" lamps, it seems that the most reliable method of specifying their illuminating value is to give the mean spherical candlepower. The testing of this value is less simple than the determination of horizontal candlepower, but the factor connecting these two quantities varies within small limits for the same type of lamp, and may therefore be used as a basis of testing. On the other hand, if special forms of filaments are considered variations in the factor, from 0·82 to 1·11 may be encountered. For determining mean spherical candlepower the Ulbricht globe also deserves to be more widely used.

Turning to the rating and marking of lamps, the author summarises the discussions on this subject that have appeared before the Illuminating Engineering Society in this country,* and the Institution of Electrical Engineers† in Germany. There is a tendency among makers (in Germany, for example), to inscribe only the watts and pressure on

* ILLUM. ENG. No. 4, Vol. VIII., April, 1915.
† *Elektrotechnische Zeitschrift*, 1915, p. 216.

the lamps, but to state also the candlepower in literature relating thereto. On the other hand, the public understands the meaning of candlepower better than the wattage, and the use of the former term has therefore commended itself to central stations who, as the largest purchasers, have naturally a considerable influence in determining the procedure in this respect. In Switzerland most central stations continue to have lamps marked in candlepower. The author suggests that eventually both candlepower and watts may be indicated on the lamp. Meantime the method, largely favoured in England, of rating and standardising the lamps in watts, but marking the approximate candlepower on the bulb, deserves consideration.

SUPPLY COMPANIES SHOULD TEACH GOOD LIGHTING.

THE central station as a public servant should teach the principles of good lighting. Without resorting to technical language it is a simple matter to explain this efficiency of illumination to consumers. Let them understand how essential artificial light is to modern life. Show them that the electric bill is not a war tax to which they must subscribe whether they like to or not, but rather it is a small sum for which they get something that lengthens the day and gives additional hours for labour or recreation. Explain the harm of glare, flickering, shadows, over-lighting and under-lighting—in short, the essentials of good illumination.

Only in this way can we approach the desired Utopia—a host of satisfied customers.—R. E. Smith, *Jour. of Elec. Power and Gas*, Nov. 13th.

ILLUMINATED NAME-SIGNS ON NEUTRAL VESSELS.

ONE result of the menace to neutral vessels owing to submarine warfare has been the adoption of illuminated name-signs which are visible afar off. It is stated that the Holland-America line has decided to paint the name of the vessel on the ship in large letters, and also a statement whether it is a cargo or passenger boat. In addition, boards bearing the name of the ship and its port are to be erected on deck and will be illuminated by night. Some companies are also painting their ships in the national colours.

LETTING THE PEOPLE KNOW ABOUT THEIR STREET LIGHTING.

DISPLAY lighting of the so-called "white-way" type would seem to require little external publicity, but on the recent inauguration of a system of this kind at Lowell, Mass., the local central station made effective use of the city dailies to tell the public some of the essential points bearing upon the new work.

Thus, in one advertisement, covering an entire page, the company pointed out that local labour was employed throughout in the construction of the system. The dates of beginning and ending work under the contract with the city were given, with some particulars as to the selection of lamps and poles and the amount of cable, conduit and new power-station equipment needed. A signed letter from Mr. Edison to the Mayor of the City, congratulating the latter upon the installation, was exhibited in the lighting company's office window.—*Elec. World*, Nov. 13th, 1915.

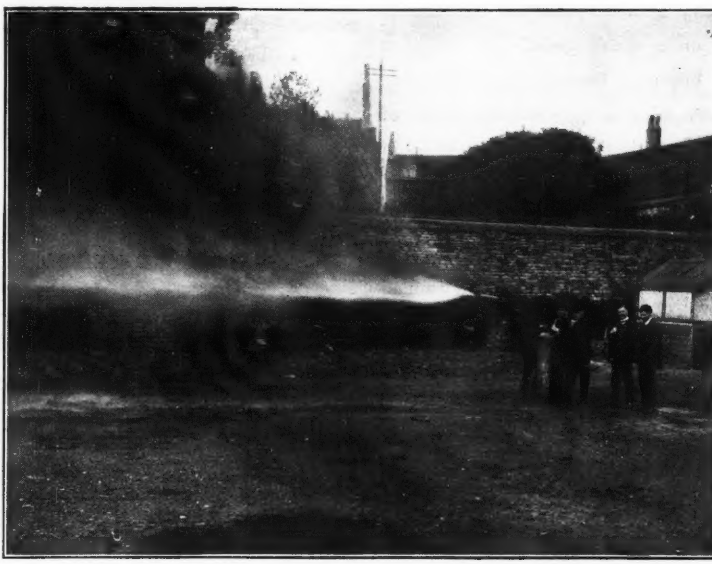
MUSIC FROM LIGHT.

IN the *Electrical Review and Western Electrician* (Nov. 13th) a novel development of the "Oscillating Audion" use in the de Forest System of radio telephony is described. The audion of a special form of electric incandescent lamp, into which a grid-shaped wire and a nickel plate are sealed, in addition to the ordinary filament. The lamp acts as a detector of wireless waves, but, if certain conditions are complied with in the electric circuit it produces an alternating current, which, acting on the diaphragm of a telephone, emits a musical note of surprising sweetness of tone. By using a keyboard controlling the electric circuit a complete octave can be obtained from one lamp, and successive octaves can be produced from others. Thus, by using a series of lamps, common to one set of telephone receivers, regular orchestral effects can be produced.

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]



THE KITSON FLAME PROJECTOR.

Readers will be familiar with the system of incandescent oil lighting supplied by the Kitson Empire Lighting Co., Ltd. The company has now designed, for military purposes, a special flame projector, which is illustrated in the above photograph.

The fuel consists of a special mixture of hydrocarbons, operated at a pressure of 200 lb. to the square inch; the burner is heated with methylated spirit in order to start the flame which is projected a distance of 60—70 yards. It is said that the heat is so intense that no one could approach close to the projector without getting severely scorched. According to *Engineering*, it is hoped to increase this distance to 100 yards.

We are informed that portable projectors capable of being strapped to a man's back are also constructed.

A NEW FORM OF LAMP FOR LANTERN AND PROJECTION WORK.

The two illustrations on the opposite page refer to a very interesting new form of lamp for projection purposes which has just been brought out by the **Edison and Swan United Electric Light Co., Ltd.**

The "Pointolite" lamp is in reality an arc within a sealed bulb. It can, however, be treated just like an incandescent lamp and, after being switched on, requires no manipulation. By the aid of a special subsidiary ionising filament an arc is struck on a small globule of tungsten which becomes incandescent all over, thus furnishing a very suitable form of source for projection purposes; it is, in fact, a "point of light," and thus differs from an ordinary incandescent lamp, consisting of a coiled filament, which is apt to give rise to striations when applied to lantern work, and is not sufficiently concentrated to give a really satisfactory image.

In the illustration a suitable form of resistance for use with the arc is shown, together with switch and special three-point holder. The whole is very compact, and is easily applied to an ordinary lantern. The type of lamp used is stated to give about 100 candles and to operate at 0·65 watts per candle.

It will be interesting to see what applications this new lamp has for cinematograph work, for which we understand special lamps (presumably of higher candlepower) will be available shortly. It is also expected that the lamp will have useful applications for searchlights.

Demonstrations of the lamp are being given at the Company's showrooms (123—125, Victoria Street, S.W.).

FIRE AT THE EDISWAN WORKS, PONDERS END.

On Saturday, December 11th, a fire broke out in the Joiners' Shop at the Ediswan Works at Ponders End. We are informed that the fire did not spread, and was fortunately confined entirely to this department. The self-contained nature of the works enabled things to be readily set going again on the Monday morning, when work was resumed.

CONTRACTS RECEIVED.

We are informed that the tender of Messrs. **Siemens Bros. Dynamo Works, Ltd.**, for the supply of Wotan, Tantalum and Carbon lamps to the Aberdeen Line for the year 1916, and also a tender to the Royal Mail Steam Packet Co., for the same period, have been accepted.

OSRAM LAMPS.—**The General Electric Co., Ltd.,** advises us that for the seventh time it has received the G.P.O. (six monthly) contract for the supply of Osram drawn-wire lamps.

The G.E.C. has also received contracts for the supply of many thousands of Osram and Robertson lamps to the Admiralty and War Office.

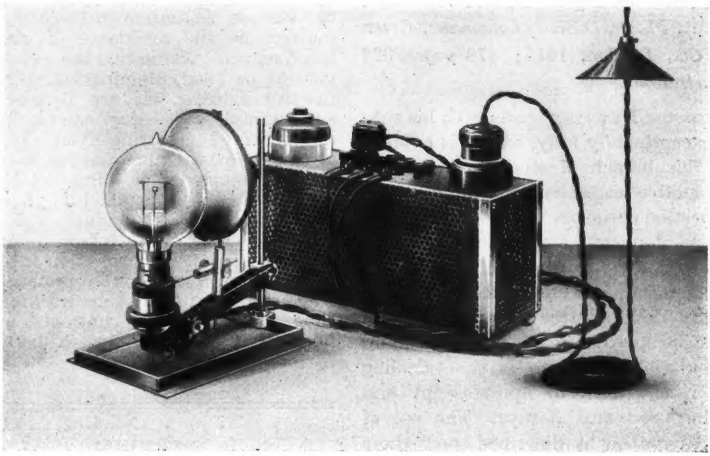


FIG. 1.—Showing "Pointolite" lamp fitted with reflector ready for insertion in lantern, together with resistance box and connections.

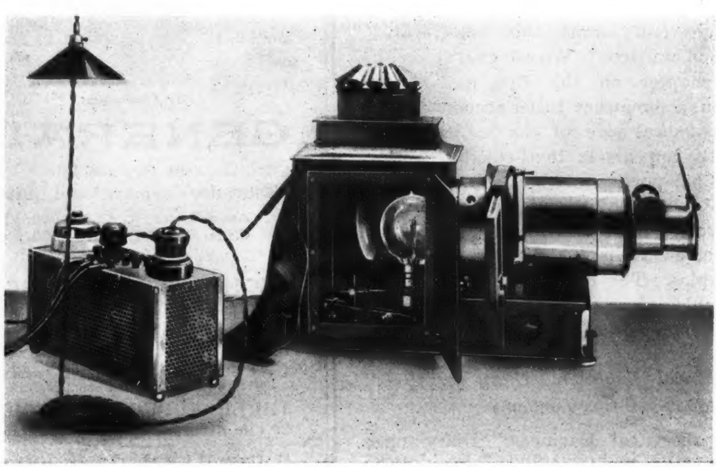


FIG. 2.—Shows "Pointolite" lamp inside lantern ready for use.

REVIEWS OF BOOKS.

"*A Treatise on Light.*" *By R. A. Houston, M.A., Ph.D., D.Sc.* (*Longmans, Green & Co., London,* 1915; 478 *pages,* 328 *illustrations.*)

PROFESSOR HOUSTON deals with his subject exceptionally fully, and it is evident that this branch of study is attracting considerable attention just now. The first portion of the bock (Part 1) deals with systems of mirrors and lenses, optical instruments, &c. In Parts 2 and 3 Physical Optics and Spectroscopy receive exceptionally detailed treatment. A section of the book which many people will find particularly interesting is that dealing with recent work in Spectroscopy and the infra-red and X-rays. The use of Echelon grating is described, and there is an excellent diagram showing the range of vibrations throughout the entire spectrum. The chapters on Photometry and Lamps and Illumination are extremely brief, and an expert would probably find several points that deserve modification. We notice, for example, that the so-called "international unit of light" is not mentioned, and among incandescent lamps the "half-watt" lamp is omitted. We are glad to see, in the chapter on the Eye and Colour Vision, a somewhat fuller account of the physiological side of the subject than usually appears in textbooks on optics. The final portion of the book is devoted to a mathematical discussion on the nature of light and radiation. At the end of each chapter there is a series of examples. The book should be of considerable interest to advanced students in optics.

"*Electrical Engineers' Diary for* 1916." (*S. Davis & Co., London.*)

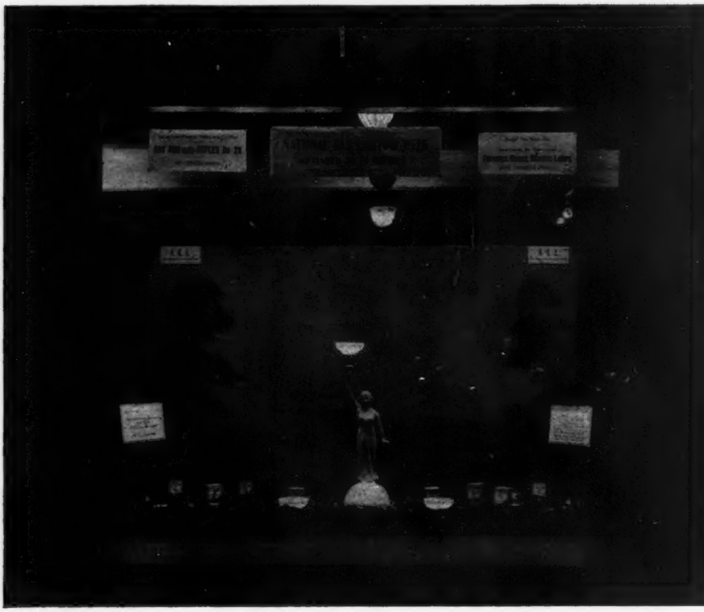
THE Electrical Engineers' Diary once more makes its appearance. Besides the familiar data on engineering matters this issue contains one entirely new feature, namely, a special section on Industrial Lighting, occupying 24 pages. The section commences with a summary of the First Report of the Departmental Committee on the Lighting of Factories and Workshops. This is followed by a series of notes on factory lighting, illustrated by photographs and data relating to various actual installations. Such matters as the avoidance of glare and inconvenient shadows, the choice of general or local illumination, direct or indirect lighting, &c., are discussed, and some simple rules for calculations of illuminating engineering given. There are also some special notes on the lighting of machine shops and clothing factories, &c. The section is concluded by a concise specification summarising the chief lighting requirements of a number of different trades. This section is particularly appropriate at the present time, when so many factories are working overtime on Government contracts, and we hope that it will form a permanent feature of the Diary.

PERSONAL.

WE note that Mr. R. H. Palmer, late advertising manager of the Welsbach Light Co., Ltd., has accepted a commission in the R.N. Motor Boat Patrol Section.

INDEX, January, 1916.

AN ATTRACTIVE GAS-LIGHTED SHOW WINDOW.



The above illustration depicts one of a series of attractively gas-lighted show windows, arranged during the recent special "Lighting Week" at Jersey City (U.S.A.).

For the photograph from which this block was made we are indebted to the courtesy of the *American Gaslight Journal*, a recent issue of which contains a number of striking illustrations of show windows.

The charm of the display lies mainly in its simplicity. The best judges now recognise that crowding of windows is almost invariably fatal to an artistic display; according to modern ideas a window should be a striking indication of the objects of the shop rather than an attempt to catalogue its entire contents. The main thing is to produce an effect which inevitably attracts and holds the passer-by.

From the lighting standpoint an agreeable feature is the soft effect produced and the absence of glare. It will be seen that the figure holds a bowl of the semi-indirect type; in this display artistic semi-indirect fittings for gas were much in evidence.

Another type of semi-indirect lighting unit which seems to be at present finding favour in the United States, utilises four bowls supported on straight arms. Not only is the subdivision of the units—and the resulting improved diffusion of light—beneficial, but the fact that the heat is less concentrated is also an advantage. There are four upward currents of air instead of one, and there is therefore less tendency to discolouration of ceilings.